❖ **Participants:**

PI: Maria Tzortziou (CCNY, NASA/GSFC)

Collaborator: Ali Omar (NASA/LARC)

❖ **Proposal concept relevant to:**

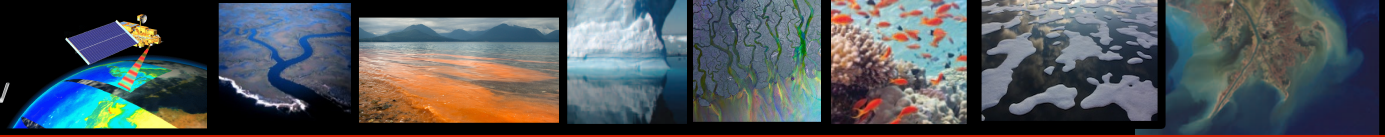
"…The two measurement suites where there is opportunity to do risk reduction and further clarify measurement requirements for future collaborative atmosphere and ***ocean science and applications on the PACE mission*** *are: (1)* ***Inherent Optical Properties (IOPs)*** *of the ocean,…" (from PACE NRA)*

"… what the ***expected scientific and applications outcomes of the proposed activities*** *will be, the measurement risk to be reduced as a result of the proposed activities, and how the risk reduction will be assessed." (PACE NRA)*

PACE

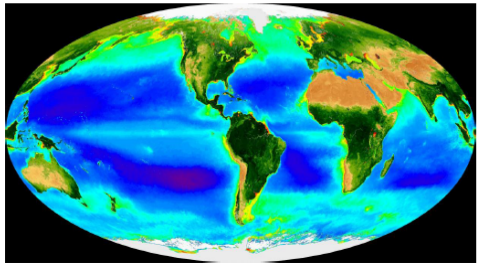
Linking PACE to Ocean Applications: A two-way approach to maximize the societal value while mitigating the risk of the PACE mission

Maria Tzortziou
maria.a.tzortziou@nasa.gov



Main Proposed Objectives

Pre-Aerosol, Clouds, and ocean Ecosystem (PACE) Mission Science Definition Team Report



October 16, 2012

PACE SDT Report, Oct 2012
PACE Mission Applications
Table 5-1, pg. 175-188

Table 5-1. PACE Mission: Major contributions to NASA application areas

PACE Mission Applications
Climate System
Carbon cycle research, mapping/assessment of carbon sources and fluxes, improved understanding of the biogeochemistry of elements involved in impacts and feedbacks of the climate system, improvement of climate models skills/forecasting capabilities, support of assessments, policy analyses, and design approaches to planning adaptation and responses to impacts of climate change.
Oceans, Coasts, Great Lakes - Ecosystems and Human Health
Fisheries and ecosystem health management, mapping of suspended sediment plumes, monitoring of water quality including transparency, eutrophication, hypoxic conditions, sediment resuspension and transport, impacts of river plumes on adjacent environments, patterns of connectivity, monitoring of oil spills and seeps, detection of harmful algal blooms (HABs), improved models of abundances of toxic pollutants, pathogens, bacteria that affect human and ecosystem health, monitoring of sea ice extent and passages, mapping of currents (applications to shipping industry, scheduling/fuel economy strategies).
Ecological Forecasting
Forecasting and early warnings of HABs, endangered species, vertebrates diversity and distribution, biodiversity, fisheries; PACE data assimilation into ocean models for improving model skills and forecasting capabilities.
Water Resources
Water quality and management of water resources in lakes, coastal areas and open oceans.
Disasters
Effects of hurricanes on ecosystems, oil-spills and oil seeps, tracking of volcanic ash, fires and impacts on ecosystems and human health.
Air Quality and Human Health*
Air quality monitoring, forecasting, management, climate change effects on public health and air quality, aerosols, clouds, volcanic ash/aviation hazard applications (see also Section 5.3).

* Many of the air quality applications would be significantly enhanced with an advanced multi-angle multi-spectral polarimetric imager.

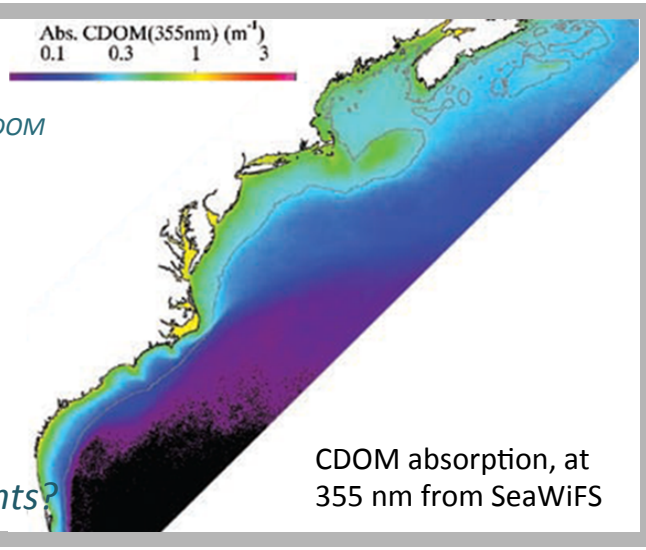
Main Proposed Objectives

Objective #1:

Bring an **applications-oriented perspective** so that the new products developed by PACE (*IOPs* a_{phyt}, a_{NAP}, a_{CDOM}, b_b *etc etc*) are **linked to specific applications questions**.

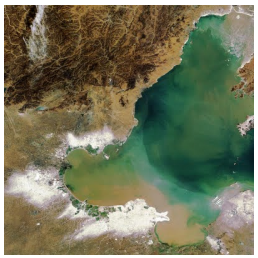
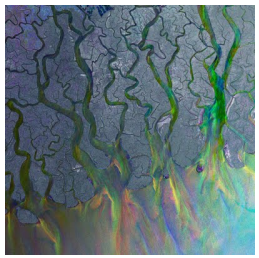
Objective #2:

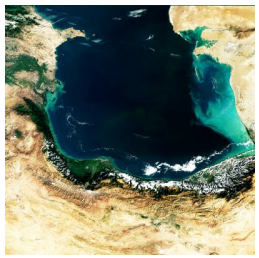
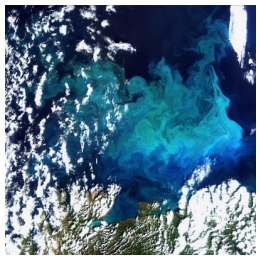
Example:
Will we be able to separate a_{CDOM} *and* a_{NAP}, *and retrieve coastal* a_{CDOM} *(water IOP relevant to coastal water quality)?*
→*How close to the shore?*
→ *At what spatial resolution? (need to aggregate pixels?)*
→ *At what accuracy?*
?? How these characteristics (proximity to shore, spatial resolution, accuracy) will be different in coastal vs open ocean environments? (where a_{CDOM} *is associated with different "applications")*
?? How do they compare with application measurement requirements?



CDOM absorption, at 355 nm from SeaWiFS

recommended by the PACE ST.


Tasks:

❖ **Achieve consensus on the spectrum of applications we can address with PACE measurements and retrieval approaches (both water IOPs and atmospheric properties retrieved)**

→ Develop a **PACE Applications sub-group**, and work within the group and with the other members of the PACE ST to achieve consensus on how we should **revise/refine the PACE Applications Traceability Matrix (ATM).**

❖ **Engage the users community**

→ **Identify key stakeholders and engage** them in discussions about PACE-derived IOPs (and atmospheric products), product characteristics, data availability, and formatting within the parameters of mission capabilities.

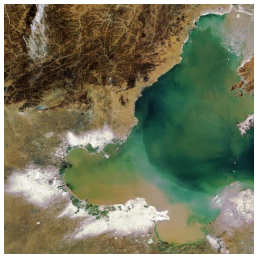
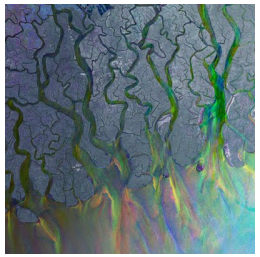
→ get input from the users community on the applications value of these product characteristics and capabilities ,and feedback from a functionality perspective

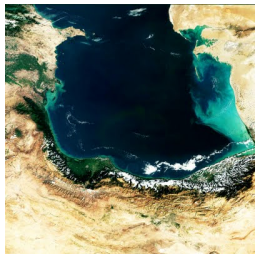
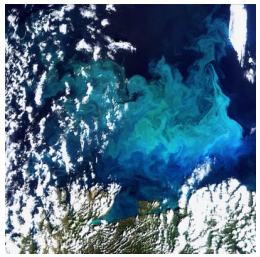
❖ **Develop communication plans and tools** for PACE products (water IOPs & atmospheric properties)

→organize outreach activities (**dedicated website**, **workshops**, and **town halls**)

→ develop **White-Papers** on current PACE Mission Applications areas

The same communication plans and tools can be used in the future for other PACE retrieved parameters (e.g., biogeochemical variables)


Applications Traceability Matrix

(with input/requirements from user community representatives, e.g., NOAA, EPA, USGS, FAA)

Application Question	Application Concept	Application Measurement Requirements	Applied Sciences Category	Potential Host Agency	Mission Data Product	Pro M Perf
What is the air quality forecast of particulate matter (PM) predicted from PACE measurements of the aerosol optical depth (AOD) in regions where there are no direct	The Environmental Protection Agency produces a daily air quality index which comprises both the ozone and particulate matter concentrations. In regions where there are no direct measurements of PM, satellite measurements of AOD can be used to estimate PM.	Observations of AOD at spatial resolutions of less than 1 km and latencies of less than 1 hour	Public Health and Air Quality	Environmental Protection Agency [James Szykman - EPA]	Aerosol Optical Depth	AOD wit horizonta 250 m
Volcanoes: What is the volcanic ash concentration during and after a volcanic eruption? Is there an impact on air quality as a result of a volcanic material deposited in coastal/populated regions?	Can we quantify this concentration using measurements collected to support PACE atmospheric corrections in coastal regions? Can we provide useful data to enable prudent aviation volcanic ash hazard mitigation policy and advisories?	Observations of AOD at spatial resolutions of less than 1 km and latencies of less than 1 hour	Disaster Mitigation Health and Air Quality	Federal Aviation Administration (FAA), US EPA, NOAA, International Civil Aviation Organization, Volcanic Ash Advisory Centers [Shobha Kondragunta-NOAA]	Aerosol Optical Depth	AOD wit horizonta 250 m
How do exchanges across the lan-ocean interface influence carbon and nutrient loadings, water quality, and ecosystem dynamics in coastal waters?	The EPA Safe and Sustainable Water Resources Research Program (SSWR) aims at developing core indicators of water resource integrity and sustainability as well as indicators of key drivers and pressures across a range of spatial and temporal scales for use in integrated assessments. Integration of satellite observations with field measurements and modeling tools is needed to demonstrate assessment of sustainability and	Observations of Chla, Kd (water quality indicators) at: Spatial resolution (GSD local): Estuaries: ≤250m Coastal Waters: ≤500m Coverage needed (Width from coast to ocean): Minimum distance: 5.5 km Maximum distance: 22 km Latency 0.5-12 hours	Water Resources Oceans, Coasts, Great Lakes - Ecosystems and Human Health	Environmental Protection Agency [Blake Schaeffer, EPA]	chl-a, K_{PAR}, K_{490}	0.5 hour direct br nm res. Spatial r km2 (±1 angles a Along-tra resolutio 250 m to inland, e coastal, retrievals
How are the productivity and biodiversity of coastal ecosystems changing, and how do these changes	Assimilation of PACE satellite-derived optics and biogeochemical variables into operational seasonal-interannual models (Global Ocean Data Assimilation System / Coupled Forecast System (CFS): Real-Time	chl-a, K_{PAR}, K_{490} Spatial: 1 km Temporal: daily Coverage: Global Latency: 12 hours	Ecologial Forecasting	NOAA [Paul DiGiacomo, Cara Wilson NOAA]	chl-a, K_{PAR}, K_{490}	0.5 hour direct br nm res. Spatial r km2 (±1 angles a

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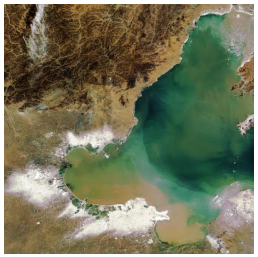
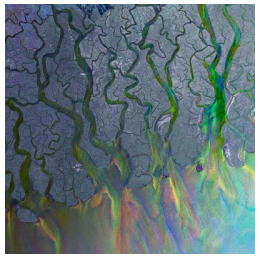
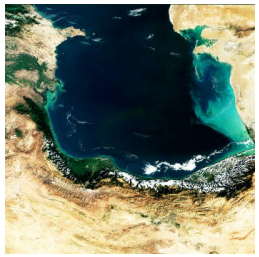
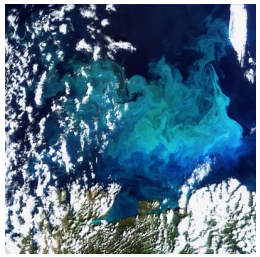
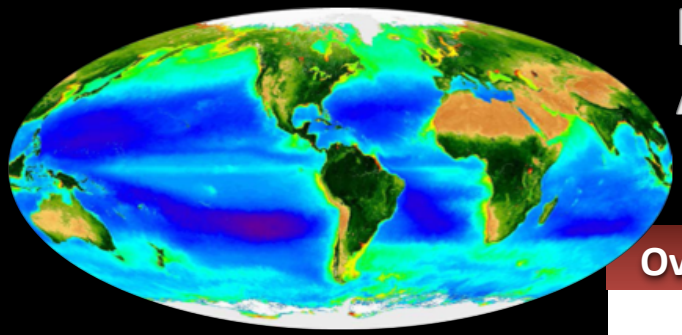
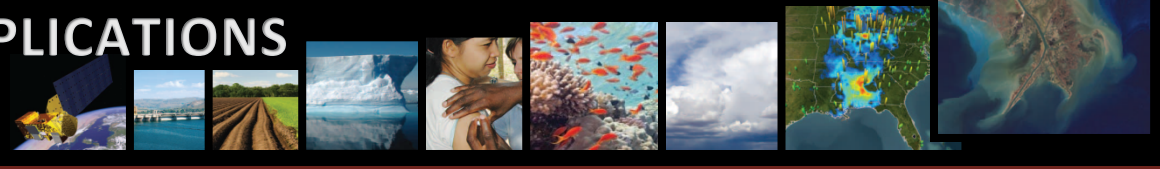



PACE Pre-Aerosol, Clouds, & ocean Ecosystem APPLICATIONS



Overview

Follow Us ...

The overall goal of the PACE applications program is to identify potential user communities and areas of applications for this future NASA mission, to ensure that the product suite and delivery mechanisms maximize the usefulness of the data.

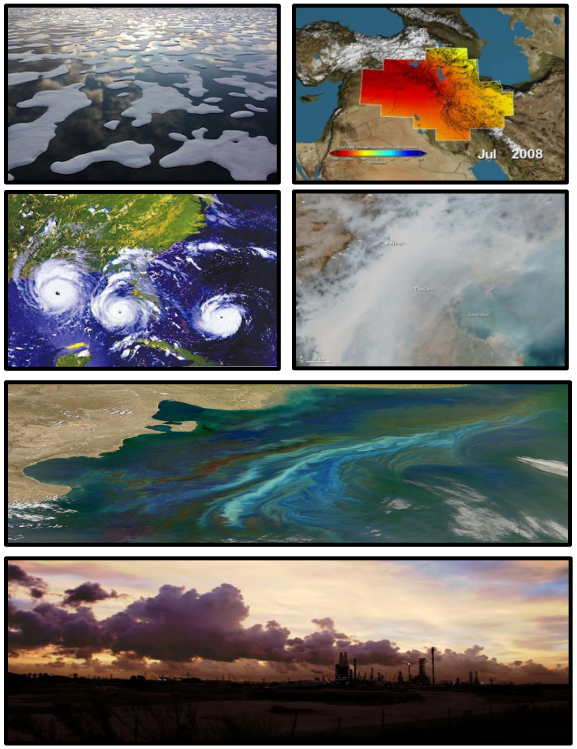
Relevance to NASA's Applied Sciences Program

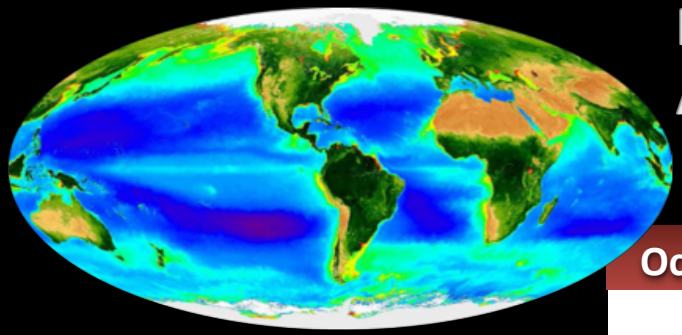
The NASA Applied Sciences Program (ASP) promotes and funds activities to discover and demonstrate innovative uses and practical benefits of NASA Earth science data, scientific knowledge, and technology.

The ASP, in coordination with the PACE Applications Working Group and the PACE Science Team will partner with public and private organizations on ways to apply data from PACE and its scientific findings in their decision-making activities and services, helping to improve the quality of life and strengthen the economy.

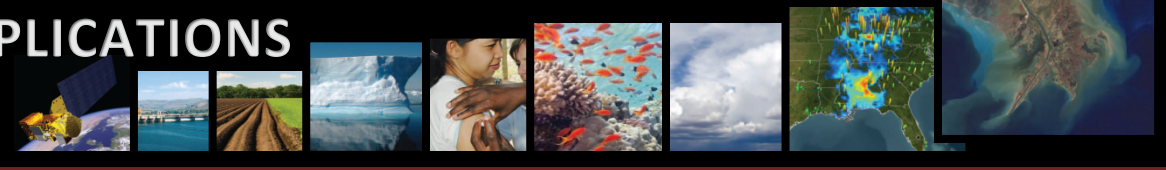
PACE observations will benefit a broad spectrum of public groups, including operational users in various tribal, local, state, federal, and international agencies; policy implementers; the commercial sector; scientists; educators; and the general public. The combination of high-quality, global atmospheric and oceanic observations provided by the PACE mission will provide direct benefits to society in the following major NASA application areas:

- Oceans
- Water Resources
- Disasters
- Climate
- Ecological Forecasting
- Human Health & Air Quality





PACE Pre-Aerosol, Clouds, & ocean Ecosystem APPLICATIONS



Ocean

Follow Us ...

The PACE mission will make near-daily observations across the globe, with more frequent measurements at high latitudes. These observations will provide dynamic maps of a number of critical parameters that are needed to understand the location, status, variation, and trends in important ecosystem services.

Many applications in coastal, estuarine, and inland waters require high spectral and high spatial resolution space-based observations to resolve the complex optical signals and biogeochemical processes typically characterizing these environments. The medium (1 km) to high (250 to 500 m) spatial resolution observations from PACE will be particularly advantageous for research and societal applications in lakes, estuarine, and coastal environments, where environmental properties and the distribution of resources change rapidly over shorter distances than in the open ocean.

Climate System
Read More

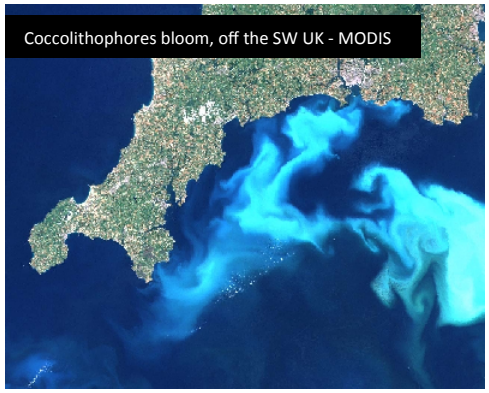
Oceans, Coasts, Great Lakes – Ecosystems and Human Health
Read More

Ecological Forecasting
Read More

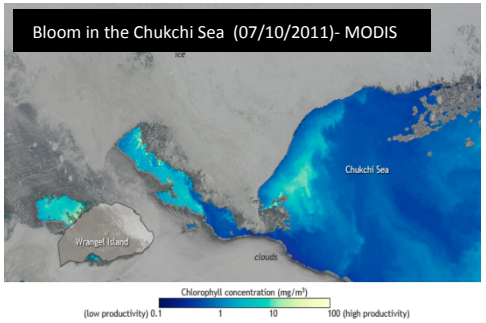
Water Resources
Read More

Disasters
Read More

Gulf of Batabano, Cuba, after the passage of Hurricane Charley – MODIS 500m resolution



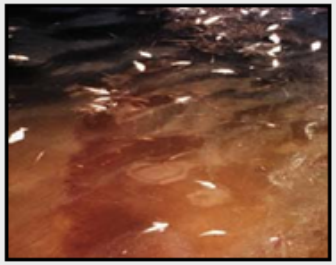
Coccolithophores bloom, off the SW UK - MODIS



Bloom in the Chukchi Sea (07/10/2011)- MODIS

White Papers – PACE Applications

PACE MISSION APPLICATIONS - Harmful Algal Blooms



Upper Left: Harmful Algal Blooms kill fish, contaminate seafood and pollute our waters (Photo from NOAA/IOOS). Lower Left: Warning sign for cyanobacteria (Image Credit: J. Graham, USGS). Right: Satellite image of Lake Erie, showing the extent of the 2011 harmful algal bloom (the most severe in decades). Credit: MERIS/NASA; processed by NOAA/NOS/NCCOS.

Application Question/Issue: ***How can we better understand the causes and impacts (economic, cultural, environmental, human health) of Harmful Algal Blooms (HABs), and how can we improve monitoring and forecasting of the location and extent of HABs using ocean observations from space?***

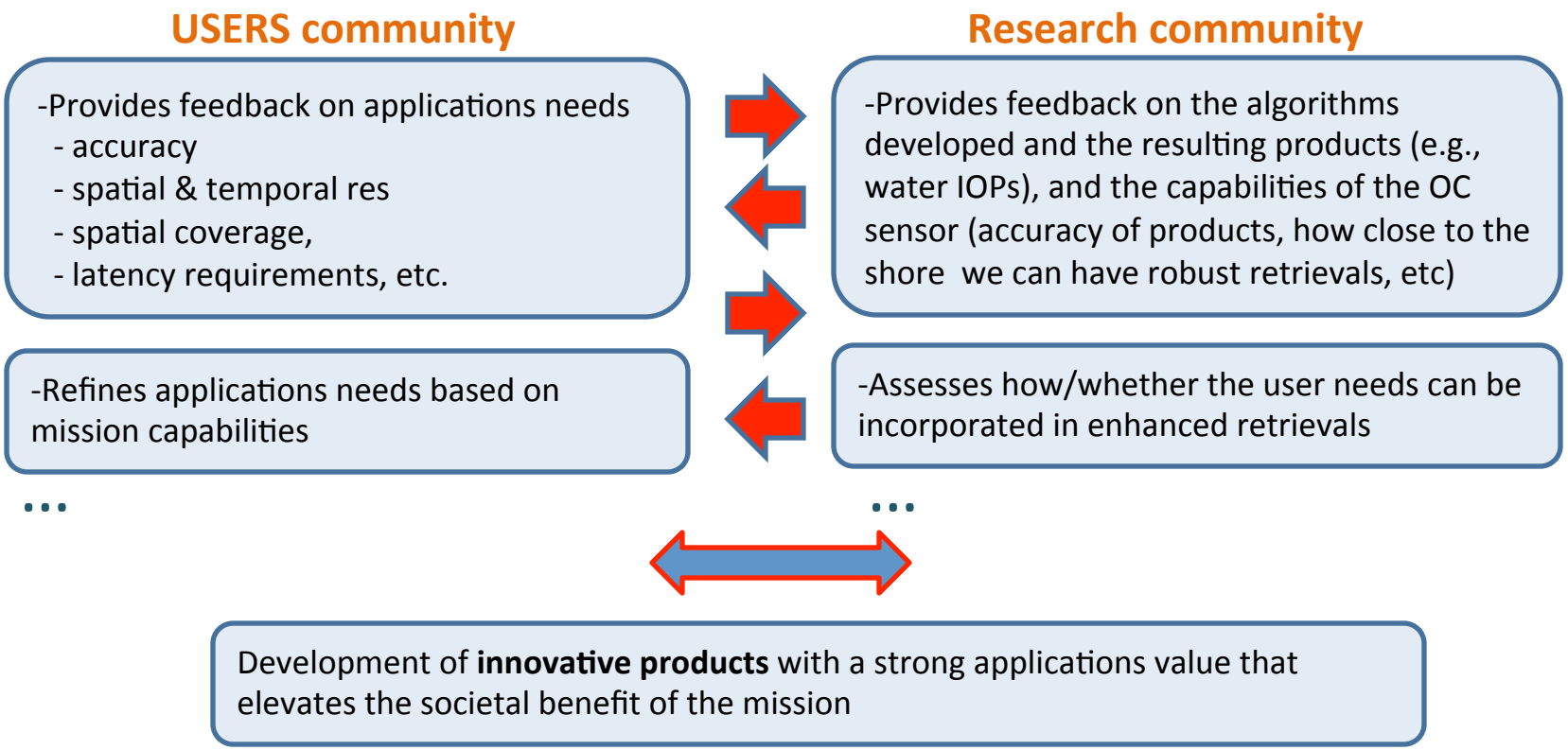
Who Cares and Why?

Coastal HAB events have been estimated to result in economic impacts in the United States of at least $82 million each year. The impacts of HABs range from environmental (e.g., alteration of marine habitats and impacts on marine organisms including endangered species), to human health (e.g., illness or even death through shellfish consumption, asthma attacks through

The NASA Response

The high (5-nm) spectral resolution measurements from PACE will allow regional algorithms to be developed for identifying and quantifying specific phytoplankton groups, thus allowing identification of HABs and tracking their evolution and variability over seasonal to interannual time scales. This information will lead to a highly sought-after understanding of environmental

Identifying and maximizing the applications value of the PACE data products is a two-way process:



The proposed activities can only be achieved through close interaction with other Science Team members focusing on IOPs, as well as Atmospheric Correction.